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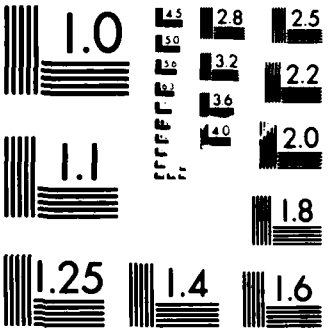

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USAFOEHL REPORT

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COMBUSTION BY-PRODUCTS ON F-4 DROGUE PARACHUTES

BRUCE J. POITRAST, COLONEL, USAF, MC
WILLIAM C. KELLER, MAJOR, USAF, BSC
ROBERT G. ELVES, CAPTAIN, USAF, BSC

June 1987

Final Report

USAF Occupational and Environmental Health Laboratory
Human Systems Division (AFSC)
Brooks Air Force Base, Texas 78235-5501

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This report has been reviewed and is approved for publication.

JOHN J. COUGHLIN, Colonel, USAF, BSC
Commander

Prepared By:

BRUCE J. POITRAST, Colonel, USAF, MC
Consultant, Occupational Medicine

WILLIAM C. KELLER, Major, USAF, BSC
Chief, Toxic and Radiation Hazard Division/HSD

Prepared By:

ROBERT G. ELVES, Captain, USAF, BSC
Consultant, Environmental Toxicology

Reviewed By:

JAMES C. ROCK, Colonel, USAF, BSC
Vice Commander

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Concerns of F-4 drogue parachute packers concerning cracking and peeling dry skin led to analysis of the parachutes for polynuclear aromatic hydrocarbons (PAH). F-4 drogue parachutes with varying numbers of deployments were analyzed for PAH. Results show a linear increase of PAH concentration with increasing deployments. Protective measures are suggested.

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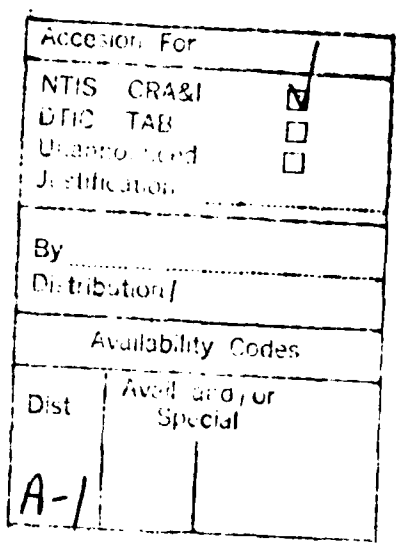

I. INTRODUCTION

A. Purpose: The purpose of this report is to highlight a potential health problem associated with F-4 drogue parachutes and recommend protective measures. The report is prepared as the result of a request for assistance made to Toxic Hazards Division of AAMRL from the USAF Medical Center at Wright-Patterson AFB. F-4 drogue parachute packers had complained to the Medical Center of drying, cracking and peeling of their skin as a result of contact with the drogue parachutes in the packing procedure. Toxic Hazard Division's analysis of the parachutes revealed contamination with long chain alkanes. Shorter chain alkanes are also present but evaporate prior to analysis. These alkanes are present due to incomplete combustion of aircraft fuel. These alkane products are defatting and are felt to be the cause of the skin problems. AAMRL suggested that USAFOEHL should make recommendations for protective measures.

Because polycyclic aromatic hydrocarbons (PAH) are known by-products of combustion from airplane engines, drogue parachutes were analyzed for PAH. Concentrations of PAH were found on the parachutes and were found to increase directly with the number of deployments of the parachutes (Tables I and II). In addition the more heavily used parachutes had detectable amounts of N-nitroso-amines.

B. Problem: The PAH discussed in this report are the same ones that are of concern in coal tar pitch, a known human carcinogen. In animal experiments, 80% of PAH placed on the skin are absorbed and excreted within 24 hours if no attempt is made to wash them off. Washing the site immediately is practically ineffective since this reduces the amount excreted by only 20% and 60% are still excreted.

Drogue parachute packers have abraded, dry, cracked skin. PAHs are readily absorbed through intact skin. Significant amounts of PAH may be absorbed by the packers due to direct contact with contaminated parachutes.

C. Scope: This report will present data showing an increase of PAH and other substances on drogue parachutes correlating with extent of use and recommend protective measures.

II. METHODS: Samples of drogue parachutes consisting of two to four square feet of material were collected from bases in Kansas, Nebraska and Texas and placed in double zip-locked bags. The bags were then placed in an opaque envelope and kept in a freezer until analyzed. Samples shipped to USAFOEHL were frozen for storage upon receipt. One square foot of material from each sample was analyzed. Analysis was done using EPA method 625 using an HP5987 GC/MS instrument and Aquarius II software. Results are in micrograms per square foot of parachute. Preliminary studies indicated the presence of PAH in drogue parachutes and an absence of PAH in patching material used as control samples.

III. **DISCUSSION:** A deployment record is usually maintained with each drogue parachute; however, parachutes may be transferred among aircraft and even among units located at different bases. This use pattern precludes association of levels of PAH with any particular type of engine, aircraft or locale. As can be seen from the accompanying tables PAH totals per square foot of parachute increased from 2.64 micrograms per square foot with 4 uses to 270.17 micrograms per square foot with 85 uses. Since a drogue parachute for the F-4 is 16 ft in diameter there is a total of 54 mg of PAH on parachute No. 17, if we assume uniform distribution. Due to the manner in which drogue parachutes are packed, exposure to packers may be considerable (Figure 1). All packers we observed used bare hands and arms to fold and pack the parachutes. This required repeated hand, arm and thorax contact with the parachutes. Most areas of the parachute were contacted by the packers during the packing operation. Uniforms were covered with an easily observed layer of oily matter. Direct skin contact with the material is made with approximately 20% of the body surface, i.e., both hands and arms. An additional 13% on the chest and abdomen suffers indirect contact. Packers frequently handle as many as 6 to 8 parachutes in a given day. If the parachutes are in the range of 80 uses this constitutes a potential contact with 400 mg of PAH a day (50 mg x 8 packing operations). Typical exposures would be some fraction of this and would depend on degree of parachute contamination and packing technique. This exposure represents a significant health risk which may be readily prevented by use of personal protective equipment.

Substances have been identified in the urine which may be used for biological monitoring of PAH occupational exposure; however, the test has not yet been developed to the point of routine use for worker health evaluation.

IV. **CONCLUSION:** Packers of F-4 drogue parachutes come in direct and indirect contact with hazardous substances on a routine basis. The majority of this contact is easily avoided.

V. **RECOMMENDATIONS:** We recommend: (1) Cotton coveralls be worn at all times during the packing procedure. These coveralls should be washed on site and not taken home. (2) Appropriate hydrocarbon resistant gloves be used for the majority of the procedure. We recognize that gloves cannot be worn during the entire procedure. These simple, readily accomplished procedures should practically eliminate any risk associated with drogue parachute packing. We are investigating engineering and monitoring procedures which may eventually eliminate the need for protective equipment.

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Table I

Comparision of Drogue Parachute Deployments and PAH Contamination

Number of uses	4	<20	15	85	>70	80
Parachute Number	4	9	12	14	15	17
Compound						
Naphthalene		3.16		5.66	15.52	22.00
fluorene	0.08				4.65	8.49
Phenanthrene		1.23		4.51	21.65	14.92
fluoranthene	0.4		2.85	13.84	27.76	17.35
anthracene	1.22	1.85	0.47	6.43	27.69	22.72
Pyrene	0.40	1.83	4.74	16.14	37.57	25.76
chrysene			0.80	11.13		15.43
benzo(a)-anthracene		0.26	1.80	5.08	24.15	22.46
benzo(b)-fluoranthene				19.19	30.67	41.87
benzo(k)-fluoranthene				23.57	37.48	51.56
benzo(a)pyrene	0.54			21.19	26.37	20.84
benzo(ghi)-perylene				6.35	0.93	7.18
indeho(1,2,3-cd)-pyrene			Trace	2.00	Trace	Trace
Total	2.64	8.33	10.68	135.19	254.44	270.17
other compounds found						
N-Nitroso-Di-N-Propylamine			10	10	14	12
N-Nitrosodi-phenylamine				0.75	1	

Results are in micrograms/ft^2 of parachute

Table II. Analytical Results for All Samples*

Number of uses				4					<20			15		85	>70		80
Parachute Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Compound																	
Naphthalene	1.47		6.46		35.70	3.97	7.76	6.99	3.16	3.79	5.42		1.42	5.66	15.52	30.93	22.00
fluorene	0.86		1.79	0.08	7.64		3.28								4.65	9.13	8.49
Phenanthrene			6.84		9.17	2.50	7.39	5.16	1.23	6.81	7.31			4.51	21.65	15.73	14.92
fluoranthene	4.20		14.42	0.4	7.73	4.09	5.98	5.25		1.05	13.85	2.85	2.83	13.84	27.76	23.33	17.35
anthracene	3.13	1.17	8.64	1.22	9.80	4.24	8.18	5.07	1.85	5.77	13.40	0.47	1.11	6.43	27.69	20.88	22.72
Pyrene	6.90	2.28	20.97	0.40	12.49	5.24	9.15	6.18	1.83	11.11	20.08	4.76	4.81	16.14	37.57	36.77	25.76
chrysene †		1.83	14.07		6.38	5.15	5.91	7.28		8.56	9.74	0.80	3.47	11.13		29.93	15.43
benzo(a)anthra-† cene	2.52	0.69	9.55		11.77	2.74	5.42	2.74	0.26	0.09	8.71	1.80	7.63	5.08	24.15	14.35	22.46
benzo(b)fluor-† anthene		1.28	14.37		6.92	3.92	6.18	0.32					17.16	19.29	30.67	16.52	41.86
benzo(k)fluor-† anthene		1.56	17.56		8.46	4.79	7.55	0.39					20.98	23.57	37.48		51.16
benzo(a)pyrene †		2.89	11.41	0.54	4.16	8.14	11.42	9.15			12.53		11.03	21.19	26.37		20.84
benzo(ghi)perylene		0.45	5.63		2.38			2.79		1.05	1.88		0.35	6.35	0.93	2.54	7.18
Indeno(1,2,3-cd)-† pyrene		Trace	Trace			Trace	Trace	Trace		Trace	Trace	Trace	3.00	2.00	Trace		Trace
Total	19.08	12.15	131.71	2.64	122.26	44.78	78.22	51.32	8.33	38.23	92.92	10.68	73.79	135.19	254.44	200.11	270.17
Other Compounds found																	
N-Nitroso-Di-N-† Propylamine														10	10	14	12
N-Nitrosodiphenyla-mine †															0.75	1	

* Control Samples were negative for PAH

Results are in micrograms/ft² of parachute number of uses unknown except as indicated

† Listed in Table A3, Compilation of Substances classified as Carcinogens in Documentation of the Threshold Limit Values, 5th ed.

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